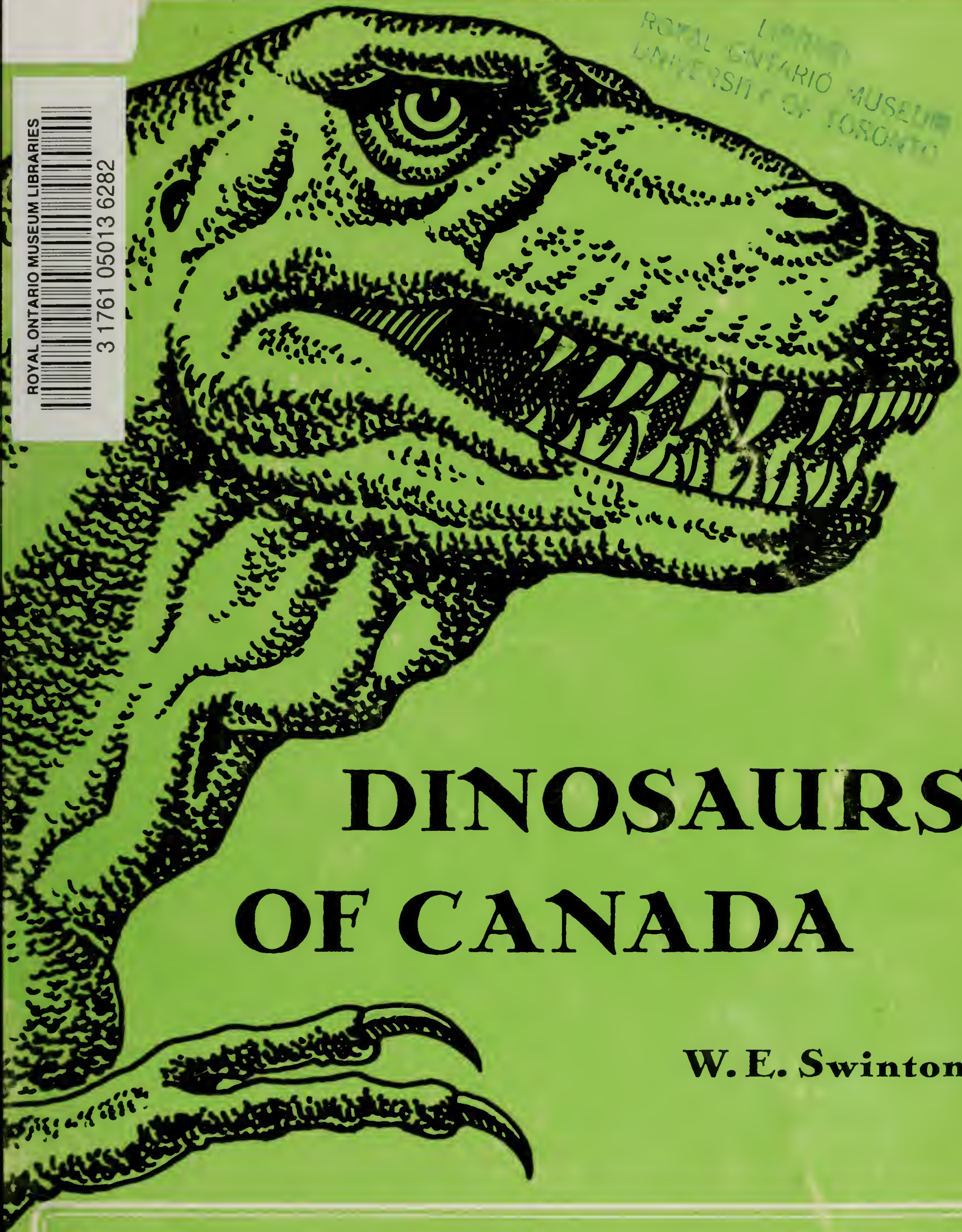
P.S.
Ro
672
no.5

ROYAL ONTARIO MUSEUM LIBRARIES
3 1761 05013 6282

AT? Why? WHEN? HOW? WHERE? WHO?

LIBRARY
ROYAL ONTARIO MUSEUM
UNIVERSITY OF TORONTO



DINOSAURS OF CANADA

W. E. Swinton

Royal Ontario Museum / University of Toronto

I keep six honest serving-men
(They taught me all I knew);
Their names are WHAT *and* WHY *and* WHEN
And HOW *and* WHERE *and* WHO. RUDYARD KIPLING

ROYAL ONTARIO MUSEUM SERIES

WHAT ? WHY ? WHEN ? HOW ? WHERE ? WHO ?

1 *K. B. Brett:* WOMEN'S COSTUME IN EARLY ONTARIO
2 *Gerald Stevens:* EARLY ONTARIO GLASS
3 *Walter M. Tovell:* THE NIAGARA ESCARPMENT
4 *R. R. H. Lemon:* FOSSILS IN ONTARIO
5 *W. E. Swinton:* DINOSAURS OF CANADA
6 *L. S. Russell:* THE MASTODON

© The Governors of the University of Toronto, 1965

This series was edited in the Information Services of the Royal Ontario Museum by Ian Montagnes. It was designed by Harold Kurschenska, and printed at the University of Toronto Press. Illustrations in this booklet are by Paul Geraghty, ROM artist craftsman.

Quotation from THE JUST SO STORIES *by Rudyard Kipling, by permission of Mrs. George Bambridge and The Macmillan Company of Canada Limited*

LIBRARY
ROYAL ONTARIO MUSEUM
UNIVERSITY OF TORONTO

WHAT? HOW?

Why? WHERE?

WHEN? WHO?

Dinosaurs of Canada

by W. E. SWINTON

WHAT were dinosaurs?

Dinosaurs were reptiles that lived millions of years ago. No one—not even the very earliest man—ever saw a living dinosaur. Yet their bones and skeletons have been discovered in many parts of the world. We have also found impressions in stone of their skins, and their footprints, and even actual fossilized eggs and nests of eggs. So we have a remarkably clear picture of how these ancient animals looked and moved and bred. We can't be sure about their colour, but even there we can guess that they were most likely to be dark green or brown like the crocodiles today, which are their nearest living relations.

We know that they were cold-blooded reptiles which got their heat from the warmth of the sun and the air round them, or from the ground on which they lay or moved. Often they would escape from the heat into the shade of the trees. They all lived on land. Even those which spent much of their time in water frequented only lakes, rivers, and perhaps estuaries or deltas; they did not venture into the sea (which then covered most of the Canadian prairies and other areas that now are dry land), though bodies of dead dinosaurs were sometimes washed out to sea and were covered and preserved by marine deposits.

Although all dinosaurs were reptiles, not all reptiles were dinosaurs. Those which lived in the sea (such as the ichthyosaurs and the plesiosaurs) or glided on long, naked wings (such as the pterosaurs) were not dinosaurs, though they lived at the same time.

It is extremely difficult to define exactly what is a dinosaur. No single character describes them. Between many kinds of dinosaur there were distinct differences so great that questions have been raised whether they should indeed be classed as a single order. Even the name is misleading. The word dinosaur means "huge reptile", but not all these animals were huge. Some were no bigger than a large dog or donkey. The biggest of them were, however, the largest land animals that we know, about 80 feet long and 30 tons or more in weight, exceeded in size only by the blue whale which can reach more than 100 feet in length and weigh 100 tons.

In Canada, expeditions have uncovered a wide variety of dinosaurs, but most date from the latter period of the Age of Reptiles, the Cretaceous. While they therefore represent some of the highest forms of development of these animals, they do not include many of the better-known and more bizarre varieties. Many are known only from skeletons in the Royal Ontario Museum and the National Museum of Canada.

Most of the dinosaurs must have been fairly harmless, slow-moving creatures which fed entirely on plants. They were preyed upon by ferocious flesh-eaters, equipped with sharp teeth which sometimes were recurved and often had saw-like edges. These carnivores walked or ran on strong, muscular hind legs, with their bodies bent forward and their tails off the ground as a counterbalance. Their forelimbs were always much smaller than their hind legs, and may have been used for grasping their prey. The hind feet had three or four toes and often bore sharp claws. Because they walked on their toes, like most mammals, these flesh-eaters are known generally as Theropods, or "beast-feet". They ranged greatly in size: at one extreme was the lightly-built American Triassic *Coelophysis*, which was nearly eight feet long but because of its hollow bones weighed only 45 pounds; on the other hand were Cretaceous giants such as the formidable *Tyrannosaurus*, 45 feet long and some eight tons in weight. In between were the English *Megalosaurus* and the U.S. *Antrodemus* (or *Allosaurus*) which were about 30 feet

Gorgosaurus, *one of the largest and latest of the flesh-eating dinosaurs, appears to have measured up to 30 feet over the head, backbone and tail. It weighed about eight tons. Remains are known only from deposits in Alberta that were formed about 80 million years ago.*

PG '65

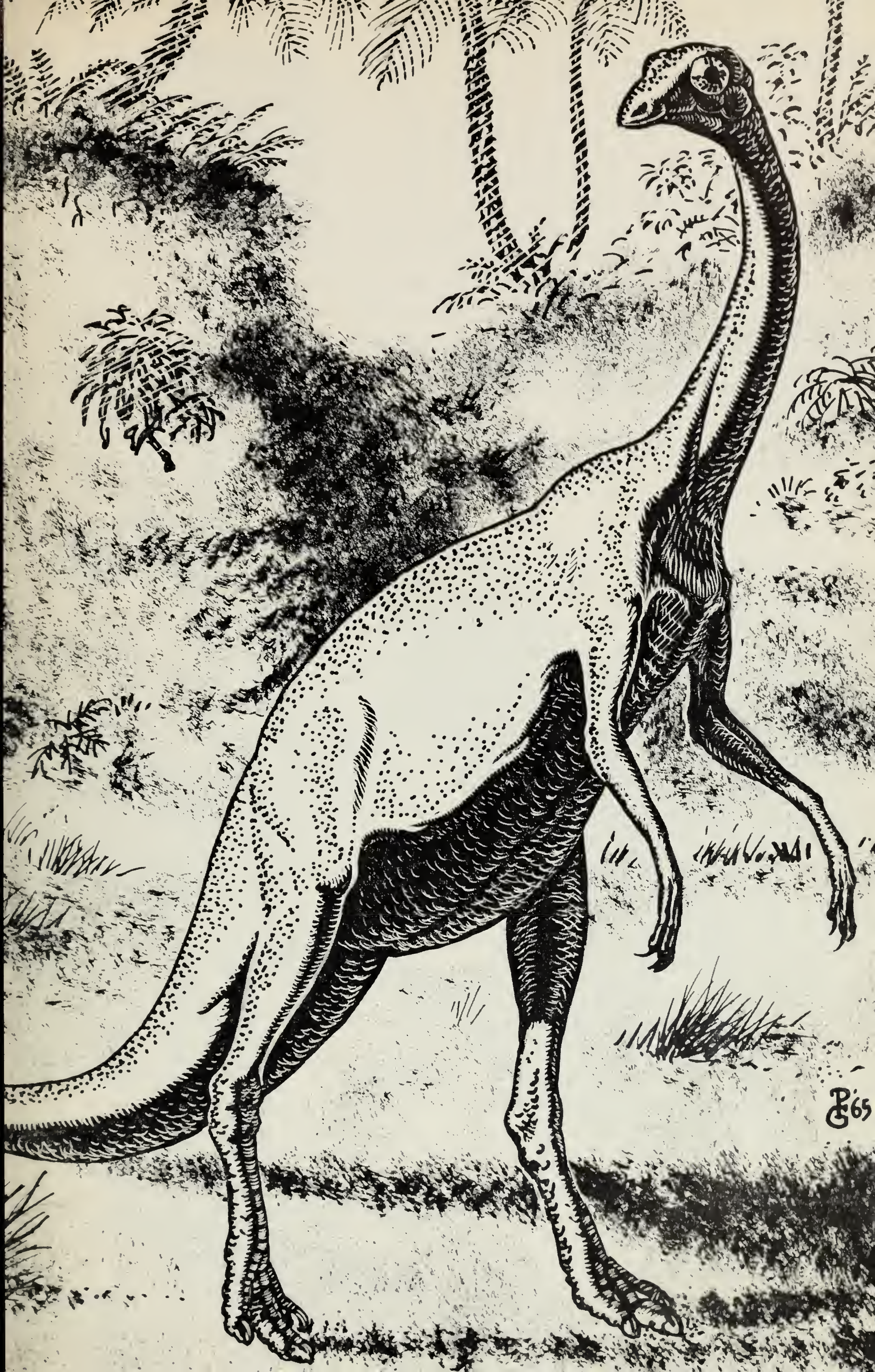
long. The Royal Ontario Museum has excellent skeletons of the small *Coelophysis*, the larger *Gorgosaurus* and the even larger *Albertosaurus*. It also shows models of the skulls of related forms, *Tyrannosaurus* (U.S.A.) and *Tarbosaurus* (U.S.S.R.). Two of its smaller, but important, skeletons are of *Ornithomimus* ("bird-mimic"), an aberrant form of carnivore which lost its teeth and had to find other food. It may have eaten insects or fruit.

A second group of dinosaurs, the Sauropods ("reptile feet"), were descended from Triassic Theropods, but developed a very different appearance and way of life. They were vegetarians and walked on all four feet. Among them were the ponderous *Brontosaurus* ("thunder-reptile"), the longer but slimmer *Diplodocus* and the high-shouldered and massive *Brachiosaurus*. These dinosaurs were from 60 to 80 feet long and weighed something like 50 tons. Such ponderous bodies and their more than elephantine legs could be borne easily only in water, whose buoyancy would take the weight off their feet. In water, too, the Sauropods could find greater safety from the large carnivores. Apparently in deepish water of lakes and estuaries these great animals floated, propelling themselves along by pushing their front legs on the bottom. No sauropod remains have yet been found in Canada.

The third group of dinosaurs is known as the Ornithopods ("bird feet"), whose three-toed footprints certainly show a similarity to those of large birds and were often mistaken for them even by geologists. These dinosaurs were bipedal, heavy of body and vegetarian. The earliest forms were small, with small heads, and teeth suited for chewing leaves and coarse vegetation. The small English *Hypsilophodon*, which was only five feet long, may have been able to climb trees. The Museum has remains of a very similar form, *Thescelosaurus*, from Canada. *Camptosaurus*, also North American, was slightly larger but much heavier; it was able at times to move on all fours, since its front legs were comparatively long.

The most remarkable of the large, bipedal herbivores were the Hadrosaurs ("thick reptiles") which had duck-bill snouts and in some cases had several hundred compressed teeth in their upper and lower jaws. Many Hadrosaurs, the so-called "hooded" forms, had greatly swollen nasal cavities that must have been developed because these dinosaurs habitually lived in water and occasionally ducked their heads under the surface to feed on

Ornithomimus, *the "bird-mimic", is so called because of its light build, long neck and ostrich-like skull. The similarity goes little further, though this agile little dinosaur also was toothless like a bird. It was descended from flesh-eating dinosaurs, but itself probably lived on fruits, insects and eggs of other reptiles. Skeletons have been found along the banks of the Red Deer River in Alberta.*



roots. Hooded Hadrosaurs are especially characteristic of the Canadian Cretaceous; the Royal Ontario Museum has the best collection of them, mostly from the Red Deer River region of Alberta. Standing about 14 feet high on three-toed and hoofed feet, these massive creatures might be 30 or 40 feet long and weigh eight tons or more. The hand had four fingers but no thumb and the fingers may have been joined together by skin, making a kind of flipper. The tail was long, muscular and flattened from side to side, which suggests that it may have been used in swimming.

Anatosaurus ("duck-reptile") (formerly known as *Trachodon*) is the name of the duck-billed and uncrested form. *Corythosaurus* ("helmet-reptile") was somewhat similar but had a simple dome of nostril bones on its head. In *Saurolophus* ("maned reptile"), the nasal bones were shaped like a horn on the back of the head; *Parasaurolophus* had a great tube, bent back upon itself, sticking out like an even larger horn. These strange crested or helmeted creatures are found in North America, the eastern U.S.S.R., and Mongolia. They represent one of the last lines of development of the Ornithopods.

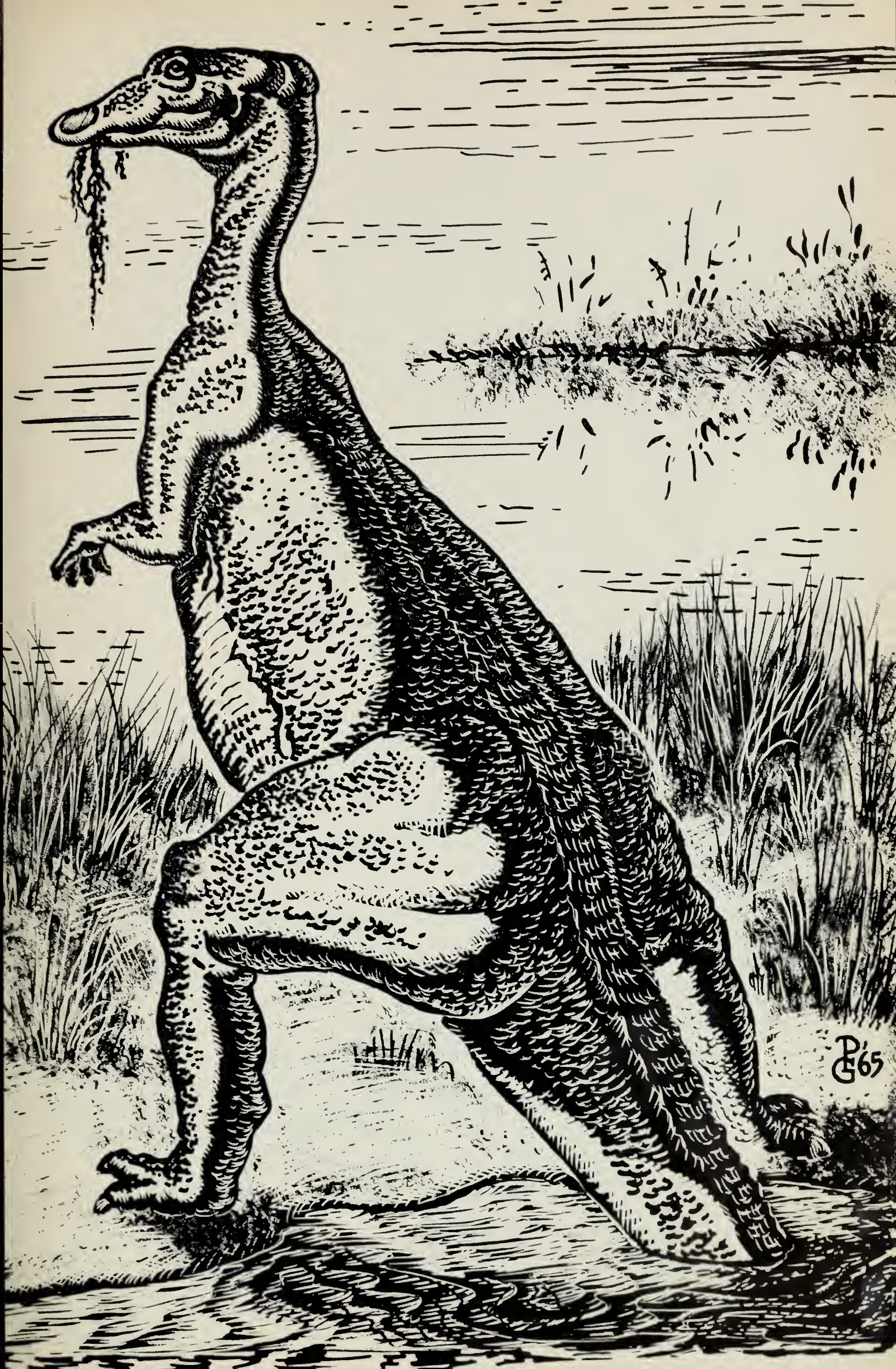
The Ornithopods had four-footed relations of several kinds that have no satisfactory general group name. They always walked on all fours, were vegetarians and were all armoured in some way on body or head.

Stegosaurus ("plated reptile") was a long, low dinosaur with an arched back on which, and on the tail, there was a row of alternating bony plates. These were roughly triangular and had their bases inserted in the skin. The end of the tail was furnished with two pairs of bony spikes. While the spikes could be used as weapons if the tail were swung from side to side, the effectiveness of the plates as armour is doubtful. Some skeletons of *Stegosaurus* are nearly 30 feet long but this size and the considerable body weight were matched by one of the smallest brains that is known.

Other arrangements of plates and scutes of bone are seen in the much more heavily armoured *Ankylosaurus* ("curved reptile") whose skull was thickly protected and whose body bore several rows of stout and keeled scutes. The tail too had a heavy bony knob at its end making it a formidable weapon of offence. The Canadian *Dyoplosaurus*, whose only known remains are in the ROM Dinosaur Gallery, was very similar. Both of these animals were about 20 feet long.

The last of the dinosaurs were the best adapted for armoured defence.

Anatosaurus*, or "duck-reptile", gets its name from its bony snout, which was somewhat like the bill of a duck. The name also includes many dinosaurs formerly known as* Trachodon. *Skeletons are known up to 40 feet long, with a presumed body weight of about seven tons.* Anatosaurus *was an amphibious vegetarian. Many closely related kinds are known from Alberta.*


PG '65

They were the Ceratopsia ("horned faces"), found only in North America though they had smaller and more primitive relations in Mongolia. Ceratopsians were rhinoceros-like animals with strong, massive legs, ending in blunt-toed feet. The body was unarmoured though the skin must have been thick. The head, however, had one or more horns on the face and a great bony frill extending over the neck. Sometimes this frill had openings (fontanelles) in it; sometimes the hinder edge was ornamented with spikes.

The greatest of these animals was *Triceratops* ("three-horned face"), with a horn on the nose and a long, sharp horn over each eye. The skull, including the frill, could be about seven feet long, the whole animal being up to 25 feet. If attacked, *Triceratops* had only to stand fast on his heavy feet, lower his horns and present this fighting front to his enemies. Nearly eight tons in weight, he would have been able to take a considerable shock, yet skulls of Ceratopsians are known which had been fractured in combat. It has been suggested that the horns might also have been used for pushing down small trees to enable the dinosaur to eat the leaves. *Triceratops* was one of the last of the dinosaurs. Other kinds of Ceratopsians, such as *Arrhinoceratops* and *Chasmosaurus* are in the gallery.

WHEN **did the dinosaurs live?**

The answer to this question is "long ago": so long ago that none of us can really grasp the meaning of the years involved. There are, however, chemical means of giving dates to the geological past which are dependent on the rate of decay or change of radioactive potassium to radioactive argon. Very elaborate studies have been made of many rocks by this method. They show that the earliest dinosaur bones and footprints are about 215 million years old. The date at which the very last dinosaurs lived was about 75 million years ago.

The three main geological periods that comprise the Age of Reptiles, mainly dinosaurs, are grouped together as the Mesozoic Age, or time of "middle life". These can be arranged, with the appropriate age in years, as shown on page 10.

Stegosaurus *was another large armoured vegetarian. Its armour consisted of a series of alternating, upstanding bony plates along the backbone, and two pairs of spikes on the tail. Its sides were open to attack. Skeletons are known that are nearly 30 feet long. The skull was carried low, near the ground, and is remarkable for the smallness of the brain—which weighed only 2½ ounces.*

PG '65

Ended 70 million years ago

CRETACEOUS
Flowering plants on the lands. Great inland seas in North America. Delta deposits and marine chalk beds formed in England.

Began
136 million years ago
Ended

JURASSIC
Toothed birds and flying reptiles over the continents, which were often invaded by the sea. Mainly evergreen vegetation.

Began
195 million years ago
Ended

TRIASSIC
First dinosaurs and mammals lived on continents. Seas were less extensive than in later periods. Desert conditions often on land.

Began 225 million years ago.

HOW are dinosaurs discovered?

The first specimens were found accidentally, but soon dinosaur-hunting grew into an art and science very much like prospecting for minerals—except that the target is much smaller and infinitely more delicate than a vein of gold. So much of our success depends on the hazards of nature that it is not surprising that a group which must have numbered many hundreds of animals may be remembered today by a single skeleton, the only one that has been discovered.

In the first place, most of the dinosaurs must have decayed soon after they died. Some, however, were buried under favourable conditions by silt or sand, which over the millions of years turned into stone. Within this protective wrapper the animal's bones also were transformed, molecule by

Triceratops, *one of the last of the dinosaurs, was a large vegetarian which might grow up to 30 feet in length. It owes its name to the two horns above the eyes and the smaller one on the nose. These could be used as weapons of attack or defence. This animal also had a great bony frill over the back of its neck, which made its skull as much as seven feet long. In Canada remains have come from Alberta and Saskatchewan.*

'65

molecule, into other kinds of stone. Thousands of skeletons must be buried thus, deep under more recent deposits, but we come across them only where a second chance of nature has at least partially uncovered the Mesozoic rock through erosion or some other process.

Both things happened in the foothills of the Rockies. During Cretaceous times, this was the shore of a great sea, along which dinosaurs flourished and died in great numbers, and in time became fossils. Later the Red Deer River cut through the rock and exposed their bones. It is from this area that most of the Canadian dinosaur skeletons have come.

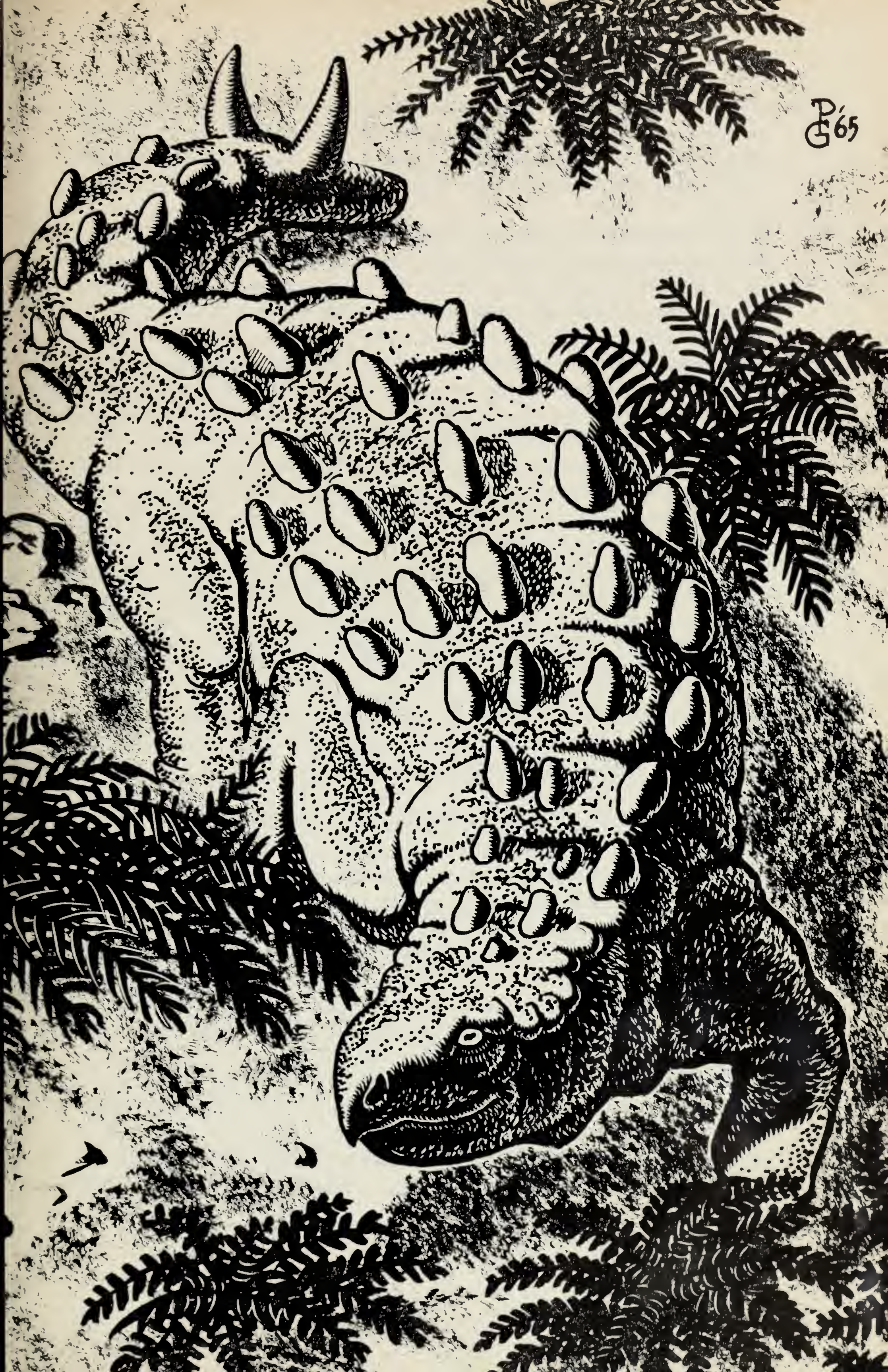
There is more sweat than romance in finding dinosaurs. The first stage is walking, often in great heat, inspecting the sides of buttes or the walls of gorges for tell-tale bones. Isolated bones, perhaps scattered by scavengers soon after the animal died, are not hard to find, but complete or partial skeletons are much more rare. Two or three bones close together may indicate the presence of more buried within the wall: the only way to be sure is to quarry the overlying rock. If a find is made, then the bones with their surrounding rock must be cut into blocks of convenient size, each weighing perhaps many pounds. These in turn are covered with burlap and plaster of paris for safe handling, boxed, and shipped back to the museum.

There begins the skilled and delicate task of extracting the individual bones from the rock. Although they have been fossilized, the bones may be split with dozens of cracks, or may crumble at anything but the lightest touch. As the matrix around them is carefully chipped away, they must be strengthened, studied, and finally perhaps re-assembled to approximate the animal's original appearance. For a single dinosaur, the job may easily take four men a solid year.

WHO has found them?

Many hundreds of palaeontologists have contributed to our present (and still rapidly growing) knowledge of dinosaurs. It is possible to mention here only a few pioneers.

Scolosaurus *was a heavily armoured dinosaur "tank". Strips of solid bone across the body were joined together by thick, flexible skin with bony pieces in it. Spikes, knobs and spines adorned the body, arms and legs. It was a slow moving vegetarian about 20 feet long, eight feet broad and four feet high, estimated to have weighed four tons. The only known example is in the British Museum in London. It came from the Red Deer River in Alberta.*


PG 65

The very first identifiable dinosaur teeth and bones that can still be examined were found in Sussex, England, in 1822 by Dr. and Mrs. Gideon Mantell. The first partial skeleton was found in 1834 and was, like the teeth and bones found earlier, of a herbivorous biped later named *Iguanodon.*

The first dinosaur remains in the United States were found in 1855. They were dinosaur teeth in Montana and two vertebrae and a toe bone from South Dakota. Though found by Dr. F. V. Hayden the bones were first described in 1856 by Dr. Joseph Leidy of Philadelphia. The first partial skeleton, also described by Dr. Leidy, was found in 1858 at Haddonfield, New Jersey. This was a herbivorous bipedal dinosaur, a Hadrosaur.

The first Canadian dinosaur material was found in 1874 by G. M. Dawson who was the geologist with Her Majesty's Boundary Commission. He found dinosaur remains in two places; firstly, at the Morgan Creek district of Saskatchewan and, secondly, in the Milk River region near Comrey, Alberta. Professor E. D. Cope identified the fragmentary remains as "dinosaurian", the Saskatchewan bones being almost certainly Hadrosaurian. In 1897 the Geological Survey of Canada began making valuable finds in this area, which now are in the National Museum in Ottawa. The University of Toronto began its collecting in the Red Deer River valley in 1912, and since 1918 has sent expeditions west nearly every summer as part of the work of the Royal Ontario Museum.

WHERE can dinosaurs be found and seen?

Dinosaurs have been found in every continent, though it must be remembered that some of the deposits in which dinosaur bones might be found have themselves been destroyed or are now unrepresented.

In Canada, skeletons and bones have been found in Alberta and Saskatchewan, fragmentary bones in Nova Scotia and footprints along the Peace River in British Columbia. Some remains have also been found in Bathurst Island, N.W.T.

In the United States, dinosaurs have been found in Colorado, Connecticut, North and South Dakota, Kansas, Maryland, Massachusetts, Montana, New Jersey, New Mexico, Texas, Utah and Wyoming.

Hadrosaur bones have been found in Mexico.

In South America, well known specimens have come from Brazil, north-west Argentina, and Patagonia.

In the Arctic, dinosaur remains have come from north-east Greenland. In Europe, Austria, Belgium, England, Scotland and Wales, France, Germany, Hungary, Portugal, Roumania and Switzerland have all yielded interesting and important specimens.

Dinosaurs have been found in Africa in the north in Morocco and Egypt, in East Africa, in Tanzania and Malawi, in the Malagasy Republic, and in South Africa and Basutoland.

Australia has localities in the northeast, in New South Wales, and in Victoria. India has produced a suite of specimens from Jubalpur and part of the old State of Bengal.

In China, large numbers of bones are known from Shantung and Yunnan region.

Well known collections have been made in the Gobi Desert, Mongolia. In the Soviet Union bones have long been known from the west and from Siberia.

We must, however, distinguish between where bones are or have been found and where they now are. For example a fine collection of Chinese dinosaurs is in the Museum at Uppsala University in Sweden. It will be helpful to give a list of the main museums with important collections of dinosaurs.

Canada: National Museum in Ottawa; Royal Ontario Museum, University of Toronto.

United States: U.S. National Museum, Washington, D.C.; American Museum of Natural History, New York City; Carnegie Museum, Pittsburgh; Chicago Natural History Museum, Chicago, Illinois; Denver Natural History Museum, Denver, Colorado; and Dinosaur National Monument, Vernal, Utah (where they may be seen in the ground).

South America: Museo de la Plata, Universidad de la Plata, Argentina.

England: British Museum (Natural History), London. University Museum, Oxford.

France: Muséum National d'Histoire Naturelle, Paris.

Belgium: Institut royal des Sciences naturelles, Brussels.

Germany: Museum für Naturkunde, Berlin (E)
Senckenberg Museum, Frankfurt am Main; Palaeontology Museum of the University, Tübingen.

Australia: Queensland Museum, Brisbane; Australian Museum, Sydney.

U.S.S.R.: Palaeontological Museum of the Academy of Science of the U.S.S.R., Moscow.

There are of course many other museums with smaller collections of actual remains or where there are casts of skeletons or models of complete dinosaurs (e.g. Calgary).

Why did dinosaurs disappear?

The dying out—or extinction—of the dinosaurs is often thought to be one of the great mysteries of the world. And so it would be if all the dinosaurs had been of one kind and habit and they had all disappeared at one stroke. We have, however, already seen that there were many kinds of dinosaurs suited for quite different kinds of life. If we follow their history we see that some kinds were disappearing, dying out all the time, and when the last days of the dinosaurs came the dinosaurs were greatly different even from their own ancestors.

We have seen that as they developed in time the kinds of dinosaurs became the largest of their line. Large size needs more food, more space for each animal, and, unless the dinosaurs were warm-blooded (as some experts say), there can be serious problems about heat control.

We also know quite well that there were great changes in the relationship of land and water throughout the Mesozoic Era. There were also changes of vegetation, with flowers and deciduous trees coming in during the Cretaceous. Inevitably there were changes in climate.

Each and all of these affected the dinosaurs. The herbivorous dinosaurs had long been used to eating evergreen vegetation and the coming of the newer kinds must have affected them, not so much by the leaves but because for a long period each year the deciduous trees were bare of any food substance. Food would undoubtedly become more difficult to get for the large vegetarians. Large animals tend to have fewer young and there would therefore be increased competition for food among the carnivores as well.

There is no doubt that towards the end of the Cretaceous, the climate of most of the world was getting cooler, and while this might not have affected the dinosaurs if they were warm-blooded, it would certainly affect the vegetation and thus, again, add to the trials of all kinds of dinosaurs.

There was, of course, the gradually increasing competition of other animals. The reptiles themselves produced very large crocodiles in the Cretaceous capable of dealing with large dinosaurs. Throughout the whole long reign of the dinosaurs, moreover, the mammals were living and diversifying. They were mainly small but their attacks on the eggs of the dinosaurs, or even on the young, may have been critical at an already critical time.

There were, therefore, quite a number of good reasons why the dinosaurs should gradually dwindle and disappear at a time when all the continents were being slowly reshaped.

By the end of the Cretaceous all the dinosaurs were gone and none is known from any later deposit.

SUGGESTED READING

COLBERT, EDWIN H. *Dinosaurs* (Dutton & Co., New York, 1961).

HOOTON, NICHOLAS, III. *Dinosaurs* (Pyramid Books, New York, 1963).

SWINTON, W. E. *The Wonderful World of Prehistoric Animals* (Doubleday, New York, 1961).

Digging for Dinosaurs (Doubleday, New York, 1962).

Dinosaurs (British Museum (Natural History), London, 1964. Available at Royal Ontario Museum sales desk).